



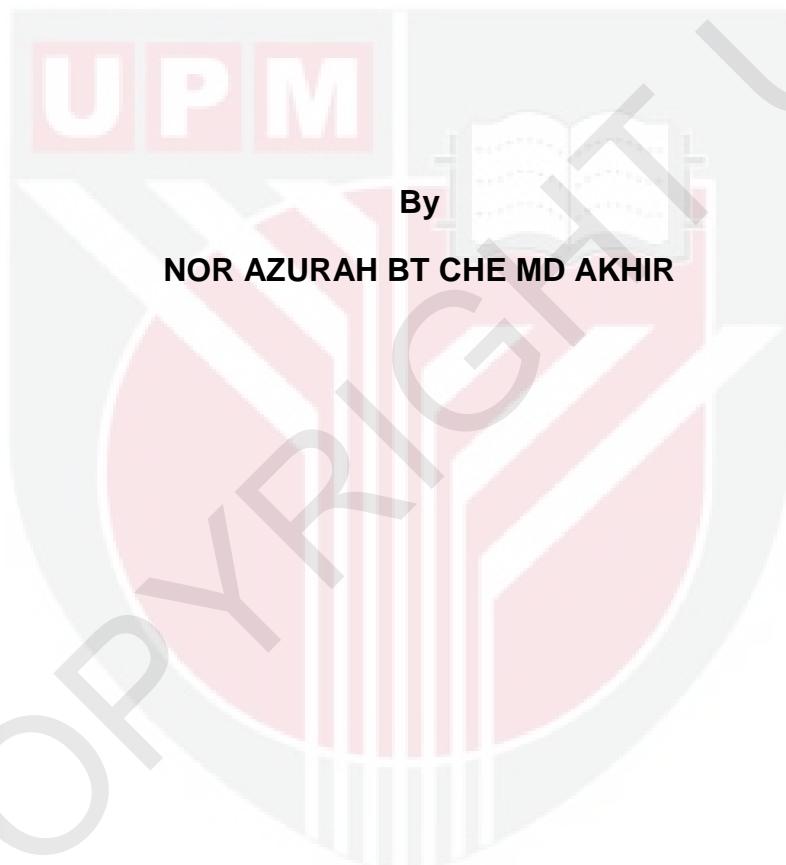
UNIVERSITI PUTRA MALAYSIA

***FATIGUE STRENGTH ANALYSIS OF STONE MASTIC ASPHALT (SMA)
MIXTURES USING CRACK MEANDER PROTOCOL***

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FK 2012 72

**FATIGUE STRENGTH ANALYSIS OF STONE MASTIC ASPHALT (SMA)
MIXTURES USING CRACK MEANDER PROTOCOL**



**Thesis Submitted to the School of Graduate Studies, Universiti Putra
Malaysia, in Fulfilment of the Partial Requirements for the Degree of
Master of Science**

July 2012

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the Master of Science

**FATIGUE STRENGTH ANALYSIS OF STONE MASTIC ASPHALT (SMA)
MIXTURES USING CRACK MEANDER PROTOCOL**

By

Nor Azurah Bt Che Md Akhir

July 2012

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Fatigue failure is a common pavement distress other than rutting and permanent deformation. Cracks are typically found along the wheel path of asphalt pavements. Initially, hairline sized micro-cracks propagate and then join together to form macro-cracks. The micro-cracks usually develop as thin, small cracks. Meanwhile macro-cracks manifest as cracks that can be seen on the pavement surfaces in the mature phase of the pavement.

Crack meander technique is a method to evaluate the fatigue strength of asphalt mixtures by mapping visual cracks on the surface of the diametral side of cylindrical sample. In this study, a 150 mm diameter sample of Stone Mastic Asphalt with 12.5 mm nominal maximum aggregate size (SMA 12.5) control sample, and two other mixture of SMA with 0.6 percent of Cellulose Oil Palm Fiber (COPF) and 6.0 percent Ethylene Vinyl Acetate (EVA) polymer respectively are tested under Indirect Tensile Fatigue Test (ITFT).

The type of aggregate gradation, asphalt type and parameters used in the test are standardized when comparison of performance is made.

During ITFT, the crack images on the sample surface are captured using a high-speed digital camera in a fixed distance from the sample for an interval of cyclic loading. Prior to fatigue evaluation, crack properties like crack length, crack area and crack density are measured by mapping of crack propagation using Measurement and Mapping of Crack Meander (MMCM) software. These three crack properties are plotted against fatigue cycle to exhibit the trend of development. The plotted graph is compared with the graph of tensile strain data against fatigue life obtained from real data in ITFT.

The comparisons that between crack length analysis and strain data shows both have the same pattern of trendline. It is found that the Crack Meander technique has a high correlation to the real data of tensile strain. This study has shows that visual crack analysis on the sample surface is a reliable approach to evaluate fatigue strength.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains

**ANALISIS KEKUATAN KERETAKAN LESU CAMPURAN ASFALT
MAMAH BATU MENGGUNAKAN PROTOKOL ‘CRACK MEANDER’**

Oleh

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Keretakan lesu adalah salah satu mod kegagalan yang biasa dialami pada jalan raya selain masalah aluran dan kecacatan kekal. Keretakan secara tipikalnya ditemui sepanjang laluan tayar pada jalan raya. Pada awalnya, keretakan halus(keretakan mikro)berkembang dan bergabung untuk menjadi keretakan yang lebih besar atau dikenali keretakan makro. Keretakan mikro biasanya bertumbuh sebagai keretakan yang halus dan kecil seperti rerambut. Manakala, keretakan makro adalah sejenis keretakan yang dapat dilihat dengan jelas pada fasa kematangan jalan raya tersebut.

Teknik ‘Crack Meander’ adalah sejenis kaedah untuk menilai kekuatan keretakan lesu sesuatu campuran asphalt dengan menggunakan konsep pemetaan dan analisis keretakan secara visual pada permukaan diameter untuk sampel silinder di makmal. Dalam kajian ini, sampel silinder asfalt mamah batu berdiameter 150 mm dengan saiz maksimum nominal agregat bersaiz 12.5 mm (SMA 12.5) untuk sampel terkawal, dan campuran asfalt

mamah batu bersama dua jenis bahan pengubah suai iaitu 0.6 peratus gentian kelapa sawit dan 6 peratus polimer Ethylene Vinyl Acetate (EVA) diuji dengan ‘Indirect Tensile Fatigue Test (ITFT)’. Jenis gred agregat, jenis asfalt dan nilai-nilai parameter yang digunakan dalam ujian adalah standard untuk semua jenis sampel supaya perbandingan dapat dilakukan.

Semasa ITFT, imej keretakan pada permukaan sampel direkod menggunakan digital kamera berkelajuan tinggi pada jarak yang tetap dari sampel yang diuji untuk selang kitaran beban tertentu. Untuk penilaian keretakan lesu ini, ciri-ciri keretakan seperti panjang keretakan, luas keretakan dan ketumpatan keretakan diukur menggunakan perisian ‘Measurement and Mapping of Crack Meander (MMCM)’. Ketiga-tiga ciri ini di-plot melawan jangka hayat lesu. Graf yang di-plot dibandingkan dengan graf terikan tegangan (tensile strain) melawan jangka hayat lesu ang diperoleh dari ITFT.

Perbandingan antara graf panjang keretakan dan terikan tegangan melawan jangka hayat lesu menunjukkan kedua-duanya mempunyai corak plot sama. Analisis juga menunjukkan teknik ‘Crack Meander’ mempunyai korelasi yang tinggi dengan kaedah konvensional menggunakan data terikan tegangan. Kajian ini menunjukkan keretakan visual pada permukaan sampel boleh digunakan untuk menilai kekuatan keretakan lesu pada campuran asfalt.

ACKNOWLEDGEMENTS

In the Name of Allah, Most Gracious, Most Merciful, all praise and thanks are to Allah swt, and peace and blessings be upon His Messenger and his relations. I would like to express the most sincere appreciation to those who made this research work possible.

First of all, I wish to express my appreciation to my supervisor Professor Dr. Ratnasamy Muniandy for his encouragement, patience, guidance and critics. I am also very thankful to the supervisory committee, Associate Professor Ir. Salihudin Hassim for their continued support and interest.

I also would like to thank my fellows at the Highway and Transportation lab of Civil Engineering department of UPM especially Mr Taher Aburkaba and Puan Nadzrol Fazilah. The good discussions we had, whether related to pavements or not, made my learning experience much more enjoyable. To the Highway lab technician, Mr Azri Tamber, thank you for your help during my lab work.

Last but not least, I would like to extend my deepest thanks to my parents, brother and sisters for their unconditional love, moral and financial support. All of u gave me strength and motivation to be a better person.

I certify that a Thesis Examination Committee has met on 12 September 2012 to conduct the final examination of Nor Azurah Bt Che Md Akhir on his thesis entitled "Fatigue Strength Analysis of Stone Mastic Asphalt (SMA) Mixtures Using Crack Meander Protocol" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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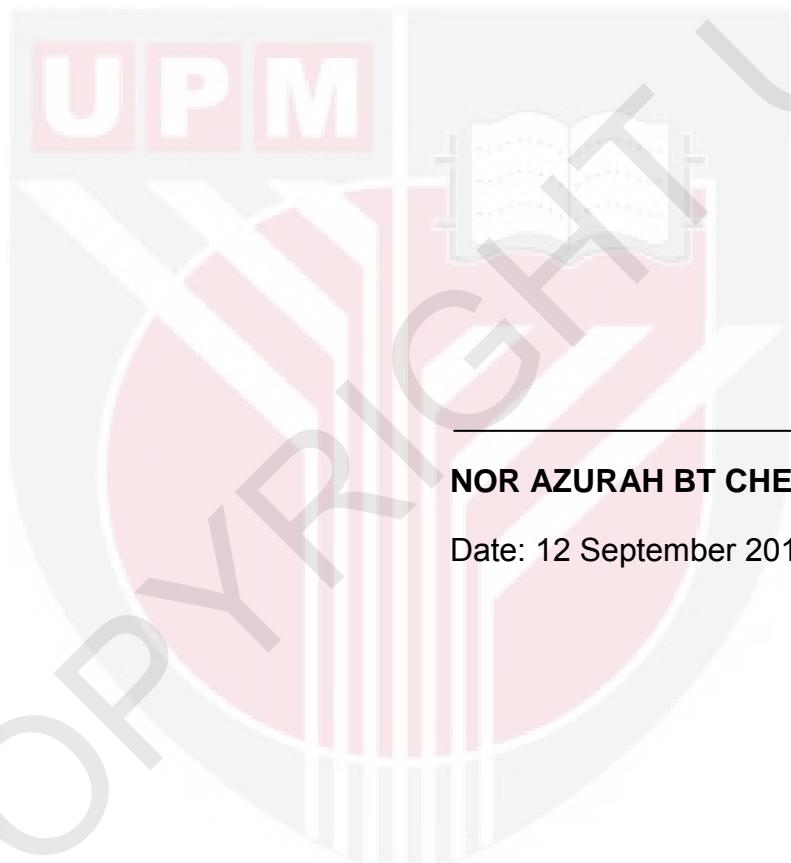
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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.



NOR AZURAH BT CHE MD AKHIR

Date: 12 September 2012

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